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AI BASED FORCE SENSING TOUCH SCREEN

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AI Based Force Sensing Touch Screen

This publication describes a method for capacitive touch screen to detect finger press action with certain force to trigger specific operation system (OS) or application (App) response on consumer electronic devices. The new finger force press detection mechanism is software base solution with AI machine learning algorithm, which can save enormous hardware cost on force sensing technique on capacitive touch screen.

Today's capacitive touch screen can detect finger touch action by the combination of Tx electrode and Rx electrode. By charging and discharging Tx and Rx electrode, touch controller can analyze the finger location by the change of mutual capacitance. The finger detection algorithm today may include a touch signal threshold and when touch signal is over pre-defined threshold, touch controller will report finger event to host system.

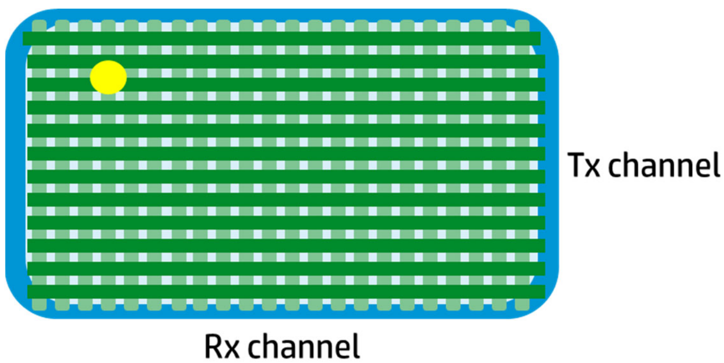

Figure 1 – Today's Capacitive Touch Screen Example

Today's force sensing technologies are mainly hardware based. The force sensing technology on capacitive touch screen required to implement force sensors under capacitive touch sensor to measure applied force value. The force sensor and lamination cost are too high to implement on consumer electronic products. The Z height could also increase because of additional force sensor component. Other force sensing mechanisms utilized the air gap or elastic substrate underneath the capacitive touch sensor to sense finger force. However, air gap or elastic substrate will also increase the cost and impact Z height, sometimes could impact user experience when user press very hard. In conclusion, existing force sensing technology on capacitive touch sensing device have many disadvantages including high material cost and additional space requirement.

In this publication, we would like to reveal new software base force sensing detection approach via AI machine learning to resolve the dilemma of hardware solution about force sensing on capacitive touch screen. By using software method, we can save tremendous cost of force sensor and lamination cost. Device Z height will not be impacted as well. In this approach, we utilize supervised machine learning algorithm to remember the force touch sequence on capacitive screen. The force touch event has certain time sequence and finger shape sequence to let AI machine learning algorithm to identify this data is force touch or normal finger touch action.

There are two key parameters regarding force input on capacitive touch screen. One is the capacitive touch signal value and signal size will increase when users press the touch screen. When users are pressing their fingers on touch screen, the more force users applied, the more finger contact area against the cover glass. The value of capacitive signal will increase along the time due to more solid finger contact area. The other critical parameter used for training is time stamp. During different touch screen scanning time stamp, the finger touch signal and finger touch area will increase gradually along the time. By identifying the two key factors of force action on capacitive touch screen, we can use AI machine learning algorithm to identify force input.

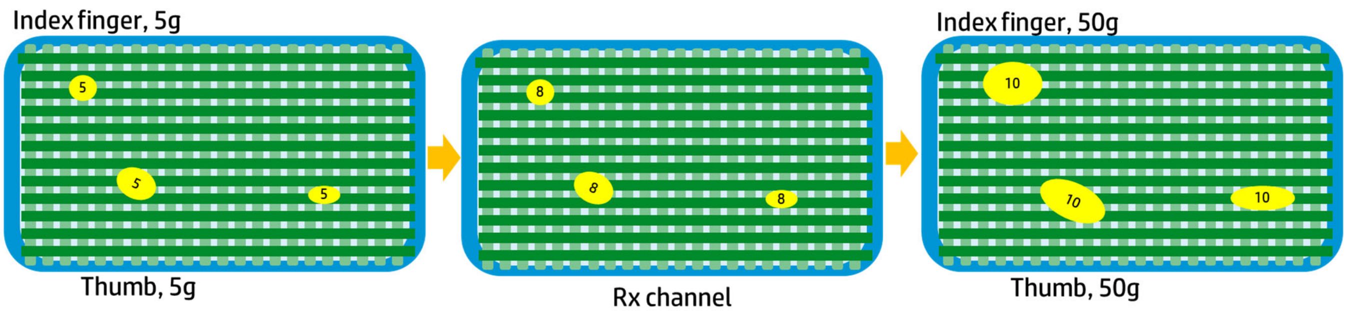

Figure 2 – Force Input Behavior on Capacitive Touch Screen

To support supervised learning, we first collect different fingers normal contact data frames and force input data frames and label whether user data are normal contact or force input on capacitive touch screen. The force input data sets include the gradual increase of finger touch signal and finger touch area. The normal non-force input data sets include constant finger touch signal and finger touch area. Different fingers consist of different shape and size so should also be taken into consideration.

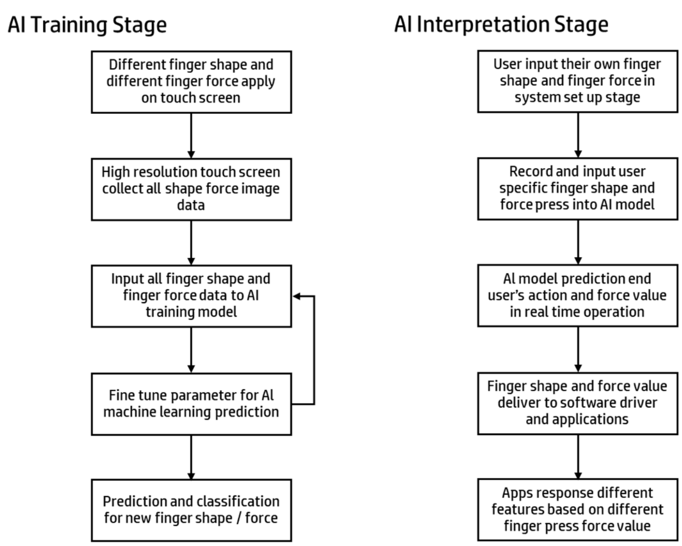

Figure 3 – Supervised learning to identify user force input or normal contact input

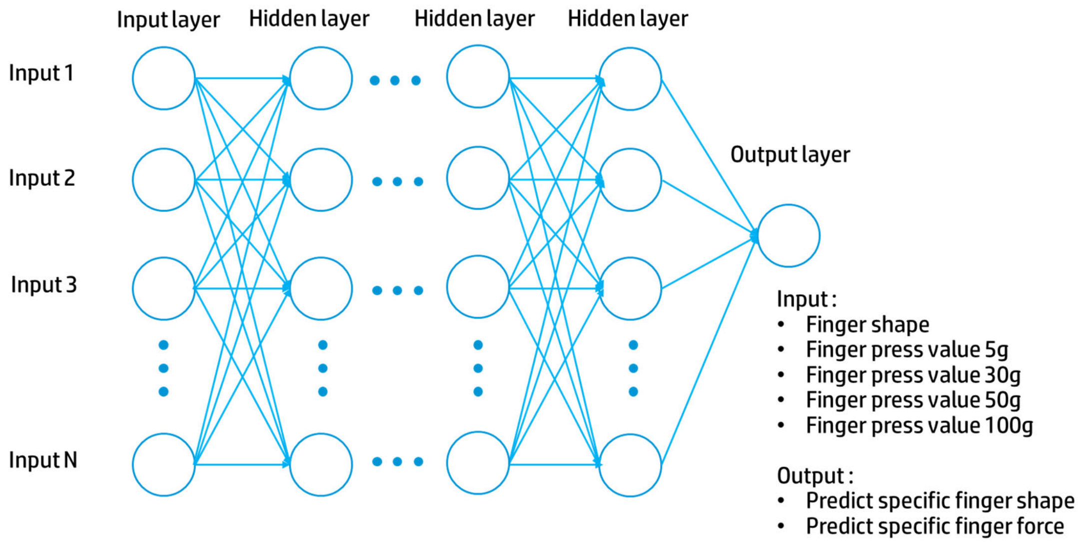

Figure 4 – Machine Learning Model to identify force input

In summary, with software base force sensing solution, capacitive touch screen can support several levels of force detection capability. The software base force detection mechanism on capacitive touch screen could be the good enough solution for consumer electronic devices. Without high-cost force sensor component and lamination process, the force detection function of capacitive touch screen could be more affordable to end users and create better user experience for customers.

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